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Snow, Jr.

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[54] **METHOD AND DEVICE FOR STABILIZING THE PATH OF A DRILLING TOOL**

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[51] **Int. Cl.**[5] **E21B 7/10;** E21B 7/08

[52] **U.S. Cl.** **175/61;** 175/76; 175/325

[58] **Field of Search** 175/61, 73, 76, 325; 166/241

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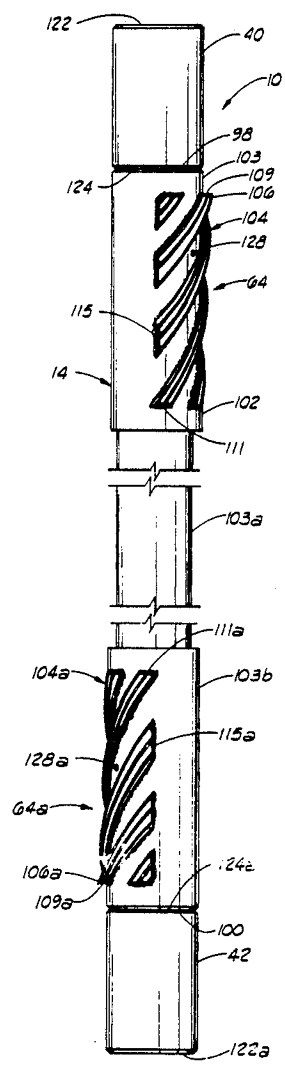
[57] **ABSTRACT**

An apparatus, and method of using the apparatus, for use in a drill string inserted into a borehole to stabilize the path of travel of a drilling tool. The apparatus is attached to the lower end of a drill string, and comprises a tubular section having a passageway therethrough communicating with the drill string passageway and a sleeve telescoped over the tubular section having at least two camming surfaces on the outer periphery thereof, the camming surfaces being substantially on opposite sides of the sleeve and spaced longitudinally along the sleeve. The rotation of the sleeve on the tubular section is selectively controlled.

7 Claims, 3 Drawing Sheets



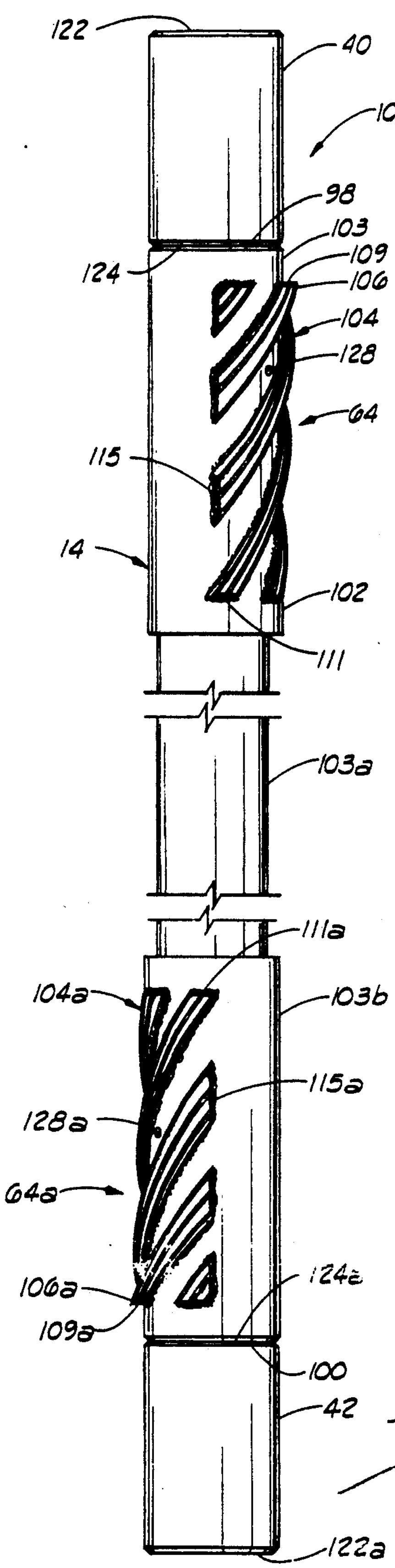

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FIG. 1

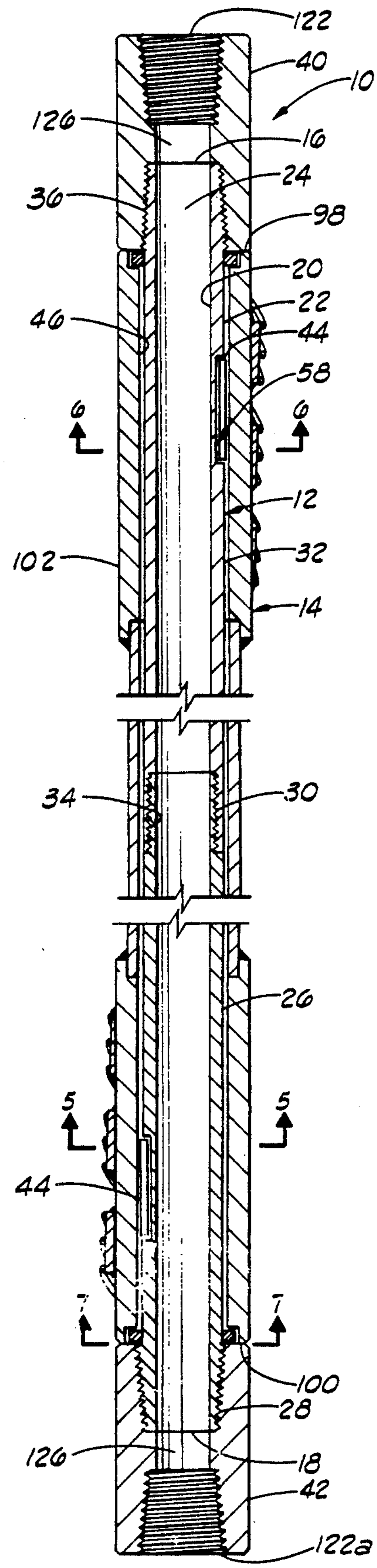
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FIG. 2

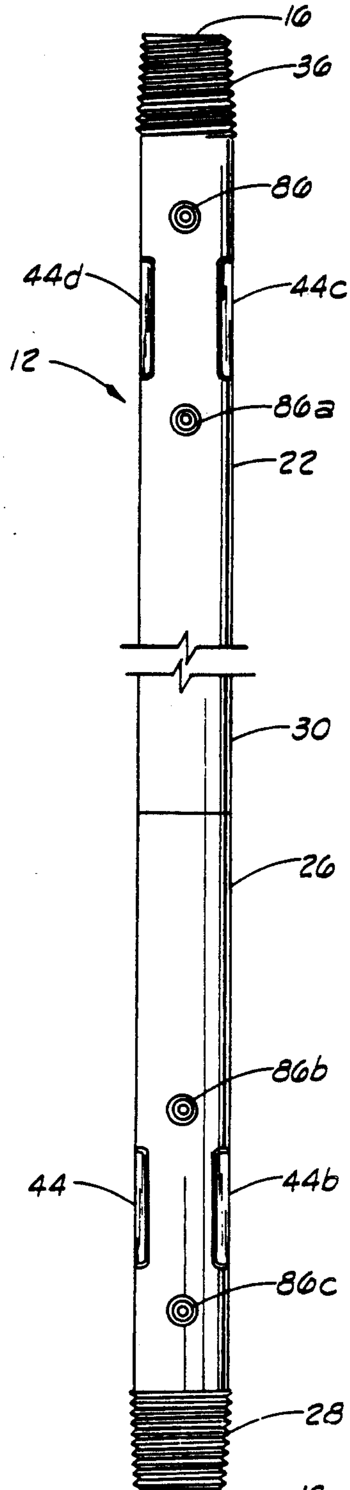

FIG. 3

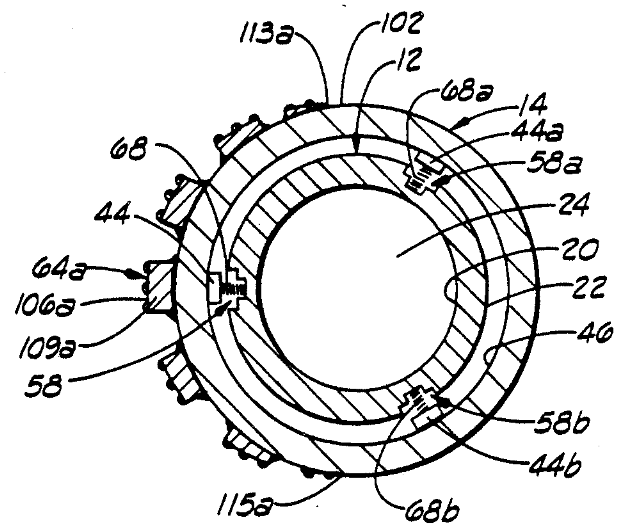

FIG. 5

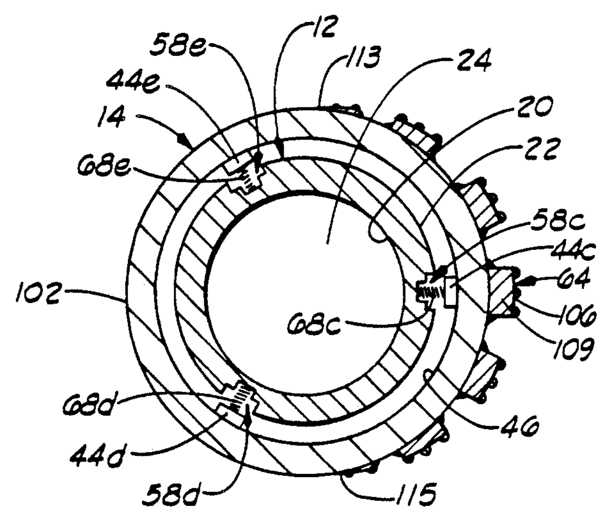

FIG. 6

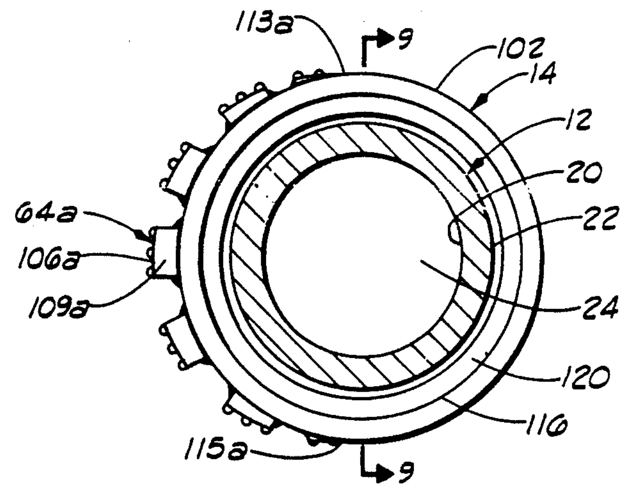

FIG. 7

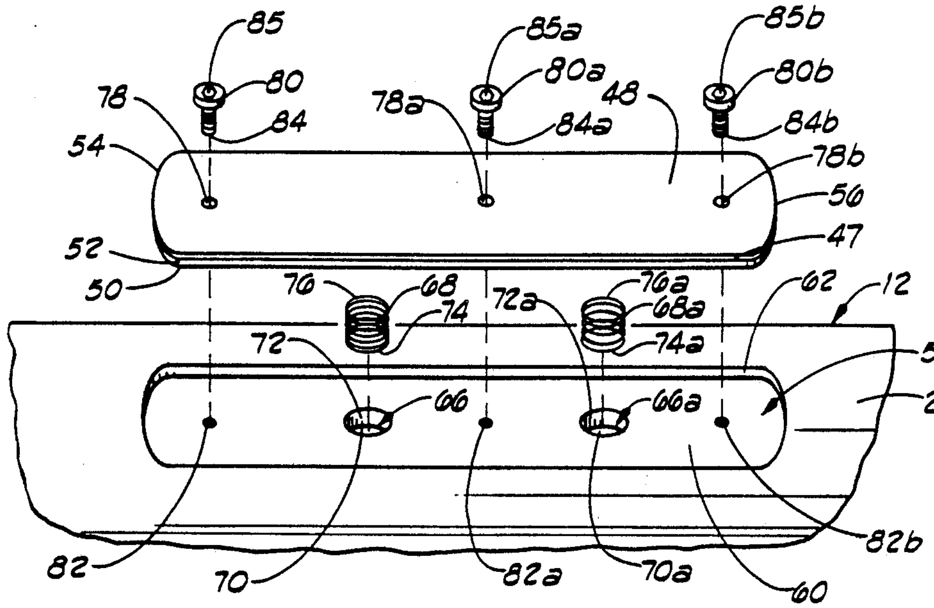

FIG. 4

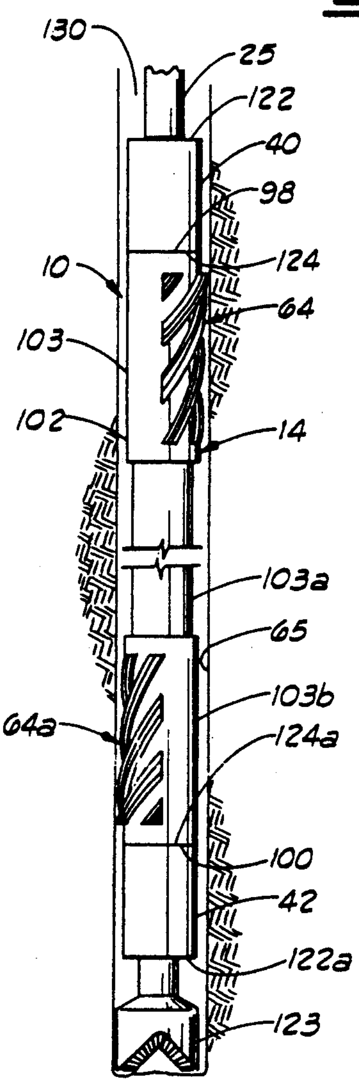

FIG. 10

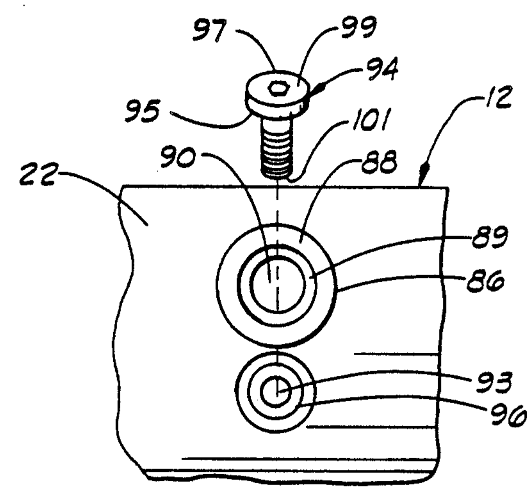

FIG. 8

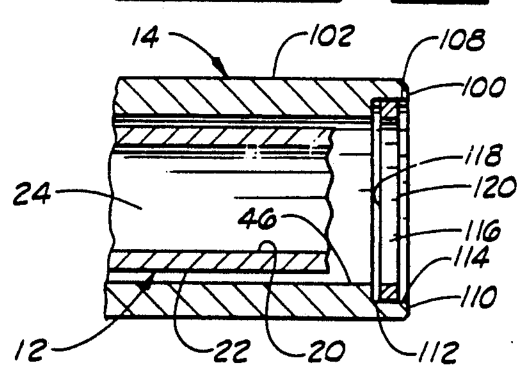

FIG. 9

METHOD AND DEVICE FOR STABILIZING THE PATH OF A DRILLING TOOL

FIELD OF THE INVENTION

The present invention generally relates to methods and devices for boring the earth, and, more specifically, to stabilizing the path of travel of a tool used to bore the earth.

SUMMARY OF THE INVENTION

The present invention comprises an apparatus for use in a drill string to stabilize the path of travel of a drilling tool attached to the lower end of the drill string. The apparatus comprises a tubular section secured in the drill string having a passageway therethrough communicating with the drilling fluid passageway through the remainder of the drill string. The outer wall of the tubular section is essentially circular in cross section. A sleeve telescopes over the tubular section which has at least two camming surfaces on the outer periphery thereof. The camming surfaces are substantially on opposite sides of the sleeve and are spaced longitudinally along the sleeve. The apparatus further comprises a means for selectively controlling rotation of the sleeve on the tubular section. The present invention also comprises a method for stabilizing the path of travel of a drilling tool attached to the lower end of a drill string utilizing the apparatus as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of the apparatus of the present invention.

FIG. 2 is a vertical cross sectional view of the apparatus of the present invention as shown in FIG. 1.

FIG. 3 is a side elevational view of a tubular section of the present invention.

FIG. 4 is an exploded view of a portion of the tubular section shown in FIG. 3 showing a shoe and recessed portion.

FIG. 5 is cross sectional view of the apparatus of the present invention taken along lines 5—5 in FIG. 2.

FIG. 6 is a cross sectional view of the apparatus of the present invention taken along lines 6—6 in FIG. 2.

FIG. 7 is a partial cross sectional view of the apparatus of the present invention taken along lines 7—7 in FIG. 2.

FIG. 8 is an exploded view of a portion of the tubular section shown in FIG. 3 showing a wear pad.

FIG. 9 is a cross sectional view of an end portion of the sleeve taken along line 9—9 in FIG. 7, wherein a portion of the tubular section has been cut away for clarity.

FIG. 10 is a side elevational view showing the apparatus secured to the drill string and a drill bit in a borehole.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in detail, and particularly FIGS. 1-2, reference character **10** generally designates an apparatus constructed pursuant to this invention. The apparatus **10** generally comprises a tubular section generally designated by the numeral **12**, and a sleeve generally designated by the numeral **14** telescoped over the tubular section **12**.

The tubular section **12** has a first end **16** and a second end **18**; it is essentially circular in cross section having an inner wall **20** and an outer wall **22**. The inner wall **20** of the tubular section **12** defines a passageway **24** which communicates with the drilling fluid passageway (not shown) in the drill string **25** (FIG. **10**) so that fluid flowing through the drilling fluid passageway will flow through the tubular section passageway **24**. The outer wall **22** of the tubular section **12** is preferably about the same outer diameter as the drill string **25**. The tubular section passageway **24** may be any size that will permit the passage of fluid as described herein but maintain the structural integrity of the tubular section **12** while in use. Preferably the tubular section passageway **24** is the same size as the drilling fluid passageway (not shown). The tubular section **12** is at least as long as the sleeve **14**, described hereafter, and is preferably a little longer.

In the embodiment shown in FIGS. **2** and **3**, the tubular section **12** comprises a first tubular segment **26** having a first end portion **28** and a second end portion **30** and a second tubular segment **32** having a first end portion **34** and a second end portion **36**. Preferably, the second end portion **30** of the first tubular segment **26** is taper threaded. The first end portion **34** of the second tubular segment **32** is internally threaded to threadingly receive and engage the second end portion **30** of the first tubular segment **26**.

The tubular section **12** may be secured to the drill string **25** by any means or may be secured to couplings which are securable to the drill string **25**. Preferably, the tubular section first end **16** and second end **18** (the first end portion **28** of the first tubular segment **26** and the second end portion **36** of the second tubular segment **32** when the tubular section **12** comprises two segments) are taper threaded Which threadingly receive and secure couplings **40** and **42**, as described hereafter.

The tubular section **12** further comprises at least one shoe **44** carried by the tubular section **12** which is urged into frictional engagement with the inner periphery **46** of the sleeve **14**, as described hereafter. As shown in FIG. **4**, the shoe **44** comprises an outer surface **48** and an inner surface **50** with a shoe wall **52** therebetween, and a first end **54** and a second end **56**. The shoe **44** may be of any size or shape and may be constructed from any material that will function as described herein.

Each shoe **44** is received in a recessed portion, generally designated by the numeral **58**, on the outer wall **22** of the tubular section **12**, wherein each recessed portion **58** has a support surface **60**, and a recessed portion wall **62** between the outer wall **22** of the tubular section **12** and the support surface **60**. The recessed portion **58** is sized to snugly receive the shoe **44** wherein the shoe inner surface **50** rests on the recessed portion support surface **60** when no pressure is applied to the shoe; in this position, the outer surface **48** of the shoe **44** is preferably about flush with the outer wall **22** of the tubular section **12**.

As previously described, the shoe **44** is urged into frictional engagement with the inner periphery **46** of the sleeve **14**. "Frictional engagement" means that the shoe **44** contacts the inner periphery **46** of the sleeve **14**, as described hereafter, so that the sleeve **14** and the tubular section **12** rotate together. This frictional engagement can be overcome in order to selectively control the rotation of the sleeve **14**, as more fully described hereafter.

Referring to FIG. **4**, one way to accomplish this frictional engagement between the shoe **44** and the inner periphery **46** of the sleeve **14** is to have at least one, and preferably two, reservoirs, generally designated by the numerals **66** and **66***a*, in the recessed portion support surface **60** which receive respectively springs **68** and **68***a* therein. The reservoirs **66** and **66***a* are sized to receive springs **68** and **68***a* capable of urging the shoe **44** into the position described herein, and sized to maintain the structural integrity of the tubular section **12**. Preferably, the reservoirs **66** and **66***a* have planar reservoir support surfaces **70** and **70***a* to support the springs **68** and **68***a*, and annular reservoir walls **72** and **72***a* disposed between the reservoir support surfaces **70** and **70***a* and the recessed portion support surfaces **60** and **60***a*. The springs **68** and **68***a* respectively have first ends **74** and **74***a* and second ends **76** and **76***a*; the first ends **74** and **74***a* contact the reservoir support surfaces **70** and **70***a* while the second ends **76** and **76***a* contact the shoe inner surface **50**. The springs **68** and **68***a* have enough length and resiliency to urge the shoe **44** a distance from the recessed portion **58** into frictional engagement with the inner periphery **46** of the sleeve **14**.

On at least a portion of the outer surface **48** of the shoe **44** is preferably an effective amount of a frictionally wearable material **47**. "Frictionally wearable material" means a material which will wear off substantially easier when contacted by the sleeve **14** than the material from which the tubular section **12** is constructed thereby reducing frictional damage between the sleeve **14** and the tubular section **12**. An "effective amount" of the frictionally wearable material means an amount which will prevent substantial friction damage between the sleeve **14** and the tubular section **12**. In a preferred embodiment, a ¼ inch layer of bearing bronze is applied by welding the bearing bronze to the shoe upper surface **48**.

As shown in FIG. **4**, the shoe **44** preferably has three apertures **78**, **78***a*, and **78***b* from the shoe outer surface **48** to the shoe inner surface **50** to receive three threaded bolts **80**, **80***a*, and **80***b* respectively therethrough. The bolts **80**, **80***a*, and **80***b* are received through the shoe apertures **78**, **78***a*, and **78***b* and secured in apertures **82**, **82***a*, and **82***b* in the support surface **60** of recessed portion **58**. The bolts **80**, **80***a*, and **80***b* are sized so that the bolt lower ends **84**, **84***a*, and **84***b* are secured in the recessed portion apertures **82**, **82***a*, and **82***b* while the bolt upper ends **85**, **85***a*, and **85***b* extend a sufficient distance from the recessed portion apertures **82**, **82***a*, and **82***b* to permit a maximum distance traveled by the shoe **44** from the recessed portions **58** in order to prevent dislodging of the shoe **44** during operation.

In a preferred embodiment shown in FIGS. **5** and **6**, there are six shoes **44**, **44***a*, **44***b*, **44***c*, **44***d*, and **44***e*; each shoe is snugly received in one of six recessed portions **58**, **58***a*, **58***b*, **58***c*, **58***d*, and **58***e*. Each recessed portion **58**, **58***a*, **58***b*, **58***c*, **58***d*, and **58***e* contains two reservoirs **66** and **66***a*, as shown in FIG. **4**, which respectively receive springs **68** and **68***a*. Any springs may be used which apply sufficient pressure to the shoes as described herein.

Preferably three shoes **44**, **44***a*, and **44***b*, as shown in FIG. **5**, are respectively received in three recessed portions **58**, **58***a*, and **58***b* which are spaced about equidistance from each other circumferentially about a portion of the tubular section **12**. Another set of three shoes **44***c*, **44***d*, and **44***e*, as shown in FIG. **6**, are respectively received in three recessed portions **58***c*, **58***d*, and **58***e* which are spaced about equidistance from each other circumferentially about a portion of the tubular section **12**. Preferably these two sets of three shoes in recessed portions are spaced longitudinally a distance apart, and more preferably these sets are positioned on the tubular section **12** so that at least one of the shoes in each set is urged against the inner periphery **46** of the portion of the sleeve **14** which carries the camming surfaces **64** and **64***a* as described hereafter.

The tubular section **12** may further comprise at least one wear pad **86**, as shown in FIG. **8**, having an outer surface **88** and an inner surface (not shown) constructed from frictionally wearable material such as bearing bronze. In a preferred embodiment, the wear pad **86** is a flattened bearing bronze ring having an annular lip **89** recessed a distance from the outer surface **88** defining passageway **90** through the middle of the ring which is sized to receive a threaded bolt, generally designated by the numeral **94**, therethrough. The wear pad **86** and the lower end **101** of the bolt **94** are received in a wear pad cavity **96** located on the outer wall **22** of the tubular section **12**. The lower end **101** of the bolt **94** is secured in the wear pad cavity bolt aperture **93** thereby securing the wear pad **86** in the wear pad cavity **96**. When the wear pad **86** is in the cavity **96**, the lower surface **95** of bolt head **97** is supported on the lip **89** so that the upper surface **99** of the bolt head **97** is recessed a distance from the outer surface **88** of the wear pad **86**, and the outer surface **88** of the wear pad **86** preferably extends a short distance from the outer wall **22** of the tubular section **12**.

The wear pad **86** functions to reduce friction damage between the sleeve **14** and the tubular section **12**: the sleeve **12** contacts the wear pad **86** before contacting the tubular section **12**. In a preferred embodiment, there are twelve wear pads **86**, **86***a*, **86***b*, and **86***c* carried by the tubular section **12**.

The sleeve **14** telescopes over at least a portion of the tubular section **12**. The sleeve **14** comprises a first end **98**, a second end **100** and is generally circular in cross section. The sleeve **14** further comprises an inner periphery **46** and an outer periphery **102**. In the embodiment shown in the drawings, the sleeve **14** is constructed from three sleeve segments **103**, **103***a* and **103***b* welded together having a uniform inner diameter. The sleeve **14** is sized to fit into a borehole and preferably has an inside diameter slightly larger than the outside diameter of the tubular section **12**. In a preferred embodiment, the clearance between the inner diameter of the sleeve **14** and the outer diameter of the tubular section **12** is 1/16 inch. Preferably, the sleeve **14** is about 2 feet to about 10 feet long, and, more preferably, about 2 feet to about 15 feet long.

The sleeve **14** has at least two camming surfaces generally designated by the numerals **64** and **64***a*, on the outer periphery **102** of the sleeve **14**, substantially on opposite sides of the sleeve **14** and spaced a distance apart longitudinally along the sleeve **14**. The camming surfaces **64** and **64***a* are sized such that the apparatus **10** will fit into a borehole and function as described herein.

Any type of camming surfaces **64** and **64***a* may be utilized in the present invention which are capable of functioning as defined herein. In a preferred embodiment, the camming surfaces **64** and **64***a* are formed by welding strips of steel **104** and **104***a* diagonally across a portion of the sleeve **14** preferably near each end **98** and **100** of the sleeve **14**. The camming surfaces **64** and **64***a* respectively have first ends **109** and **109***a* and opposing second ends **111** and **111***a*, and third ends **113** and **113***a* and opposing fourth ends **115** and **115***a*. The distance between the third ends **113** and **113***a* and the fourth ends **115** and **115***a* cover an area of about 180° of the circumference of the sleeve. The distance between the first ends **109** and **109***a* and the second ends **111** and **111***a* is about 1½ feet long.

The strips of steel **104** and **104a** are selectively nonuniform in thickness such that the camming surfaces **64** and **64***a* taper respectively towards apexes **106** and **106***a* about midpoint between the third ends **113** and **113***a* and the fourth ends **115** and **115***a* near the first ends **109** and **109***a* of the camming surfaces **64** and **64***a*. Additionally, welding beads **107** may be applied to the strips of steel **104** in order to selectively increase the height of the camming surfaces **64** and **64***a*. In a preferred embodiment, the camming surfaces **64** and **64***a* are about ⅜ inch from the outer periphery **102** of the sleeve **12** to the apex **106**. The height of the apex **106** may vary depending upon the type of drilling operation as long as the camming surfaces **64** and **64***a* function as described herein.

The camming surfaces **64** and **64***a* are preferably about 1 to about 30 feet apart longitudinally, and more preferably about 1 to about 15 feet apart. In a preferred embodiment, the camming surfaces **64** and **64***a* are 7 feet apart longitudinally.

Each end **98** and **100** of the sleeve **14** may form an annular flange element **108**, as shown in FIG. **9**. Each flange element **108** has a first end **110** and a second end **112** defining therebetween a flange support surface **114**. Each of the flange support surfaces **114** receive a floating ring **116**. Each floating ring **116** comprises a first end **118** and a second end **120**. The ring **116** is sized to snugly fit on the flange support surface **114** of the flange element **108**, but has a width (distance from the first end **118** to the second end **120**) less than the distance between the first end **110** and the second end **112** of the flange element **108**. The inner diameter of each ring **116** is preferably only slightly larger than the outer diameter of the tubular section **12** in order to fit snugly thereon. Each floating ring **116** is movably responsive from about the second end **112** of the flange element **108** to about the first end **110** of the flange element **108** when pressure is applied to the floating ring **116**, as described hereafter.

Each floating ring **116** is preferably prevented from moving past the first end **110** of the flange element **108** by the couplings **40** and **42**, although other methods to secure the floating ring **116** in the flange element **108** may be utilized. Each coupling **40** and **42** has a first end **122** and **122***a* and a second end **124** and **124***a* with a passageway **126** therethrough. The second ends **124** and **124***a* of each coupling **40** and **42** threadingly receive and engage the terminal ends **16** and **18** of the tubular section **12**. The first ends **122** and **122***a* of each coupling **40** and **42** are capable of threadingly engaging either the drill string **25** or the drill bit **123**.

The sleeve **14** further comprises at least one, and preferably two, lubricant inserting apertures **128** and **128***a* from the sleeve outer periphery **102** to the sleeve inner periphery **46**. A sufficient amount of lubricant such as oil is inserted into the lubricant apertures **128** and **128***a* in order to prevent friction damage between the tubular section **12** and the sleeve **14**. A sufficient amount of lubricant is an amount which will substantially cover the area between the sleeve **14** and the tubular section **12** but permit the floating ring **116** to remain at about the second end **112** of the flange element **108**. The floating rings **116** provide a barrier against a substantial amount of material entering the area between the sleeve **14** and the tubular section **12**, and provide a barrier against a substantial amount of the lubricant escaping the apparatus **10**.

There will be an increase in pressure on the apparatus **10** as the apparatus **10** is lowered into the borehole. The floating rings **116** are capable of movement so as to react to pressures from inside the apparatus **10** and pressures exerted on the apparatus **10**: the floating rings **116** move from the second ends **112** of the flange elements **108** to the first end **110** of the flange element **108**.

The length of the flange support surface **114** and the width of the floating rings **116** may vary. In a preferred embodiment, the support surface **114** is ⅞ inch and the width of the floating rings **116** are ½ inch.

In operation as shown in FIG. **10**, the apparatus **10** is attached to the drill string **25**, preferably directly above the drill bit **123** such that one end of the apparatus **10** is threadingly secured to the terminal end of the drill string **25** and the other end of the apparatus **10** is threadingly secured to the drill bit **123**. The drill string **25** is lowered into the borehole **130**, and the drill string **25** rotated for the drill bit **123** to operate.

The drill bit **123** often deviates from its intended relatively straight course usually due to hard formations encountered by the drill bit **123**. When the drill bit **123** alters its intended straight path of travel, the drill string **25** bends. With the present invention, as the drill string **25** bends, the camming surfaces **64** and **64***a* contact opposite sides of the borehole wall **65**. During this contact, the sleeve **14** reduces the speed of its rotation while the tubular section **12** continues to rotate with the drill string **25** and the drill bit **123**. When the apexes **106** and **106a** of the camming surfaces **64** and **64***a* respectively contact opposite sides of the borehole wall, a transverse movement in one end of the apparatus **10** is produced by camming surface **64**, and a transverse movement in the opposite direction is produced in the other end of the apparatus **10** by camming surface **64***a* which straightens the apparatus **10** and the attached drill string **25** and drill bit **123**. This stabilizes the path of travel of the drilling tool so that a relatively straight borehole is obtained.

Having a relatively straight borehole means time and money saved by the drilling operator in reaching the desired borehole depth. Additionally, the present invention also permits the application of more pressure to the drill bit **123** since bends in the drill string **25** will be corrected; this reduces the time, and therefore the expense required to drill a borehole to a desired depth.

The present invention also contemplates using more than one apparatus **10** in a drill string. The apparatus **10** on a drill string can be separated by a drill collar from the other apparatus **10** (not shown) or more than one apparatus can be positioned next to each other on the drill string.

Changes may be made in the combination and arrangement of parts or elements as heretofore set forth without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. An apparatus for use in a drill string having a drilling fluid passageway inserted into a borehole to stabilize the path of travel of a drilling tool in a borehole attached to the lower end of the drill string, comprising:

a tubular section secured in the drill string having a passageway therethrough communicating with the drilling fluid passageway through the remainder of the drill string, and having an outer wall essentially circular in cross section;

a sleeve telescoped over said tubular section having at least two camming surfaces on the outer periphery thereof substantially on opposite sides of the sleeve and spaced longitudinally along the sleeve; and

means for selectively controlling rotation of the sleeve on the tubular section comprising:

at least one shoe carried by the tubular section; and means for urging the shoe into frictional engagement with the inner periphery of the sleeve comprising:

at least one recessed portion in the outer periphery of the tubular section sized to receive the shoe;

at least one reservoir in the recessed portion sized to receive a spring; and

said spring disposed in the reservoir capable of urging the shoe into frictional engagement with the inner periphery of the sleeve,

wherein the shoe is disposed in the recessed portion.

2. The apparatus of claim **1** wherein the tubular section comprises six shoes respectively carried in six recessed portions.

3. The apparatus of claim **2** wherein three of the recessed portions carrying shoes are spaced equidistance from each other circumferentially about a portion of the tubular section and longitudinally spaced a distance from the other three recessed portions carrying shoes which are spaced equidistance from each other circumferentially about a portion of the tubular section.

4. The apparatus of claim **1** wherein the tubular section comprises two reservoirs containing springs in each recessed portion.

5. The apparatus of claim **1** wherein the shoe comprises an outer surface and an inner surface which contacts the spring, and further comprising means for reducing friction damage between the tubular section and the sleeve, comprising:

securing an effective amount of a frictionally wearable material on at least a portion of the outer surface of the shoe.

6. The apparatus of claim **5** wherein the frictionally wearable material comprises bronze.

7. A method for stabilizing a path of travel of a drilling tool in a borehole, the drilling tool being attached to a lower end of a drill string having a drilling fluid passageway therethrough, comprising:

attaching an apparatus to the drill string wherein the apparatus has a first end and a second end, the first end being attached to a portion of the drill string, wherein the apparatus comprises:

a tubular section secured in a portion of the drill string having a passageway therethrough communicating with the drilling fluid passageway, and having an outer wall essentially circular in cross section;

a sleeve telescoped over said tubular section having at least two camming surfaces on the outer periphery thereof substantially on opposite sides of the sleeve and spaced longitudinally along the sleeve; and

means for selectively controlling rotation of the sleeve on the tubular section comprising:

at least one shoe carried by the tubular section; and

means for urging the shoe into frictional engagement with the inner periphery of the sleeve, comprising:

at least one recessed portion in the outer periphery of the tubular section sized to receive the shoe;

at least one reservoir in the recessed portion sized to receive a spring; and

said spring disposed in the reservoir capable of urging the shoe into frictional engagement with the inner periphery of the sleeve; and

attaching the second end of the apparatus to one of another drill string terminating in a drilling tool or a drilling tool;

inserting the drilling tool, apparatus and at least a portion of the drill string into the borehole; and

rotating the drilling tool, apparatus and drill string thereby drilling a path of travel,

wherein the camming surfaces are capable of contacting walls of the borehole when the drilling tool deviates from a substantially straight bath of travel realigning the path of travel in the drilling tool in a substantially straight path of travel.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,995,466

DATED : February 26, 1991

INVENTOR(S) : Roy W. Snow, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 2, line 34, the word "Which" should be --which--.

Column 4, line 30, after the word, sleeve, the number "12" should be --14--.

Column 8, line 43, after the word, travel, the word --thereby-- should be inserted.

Column 8, line 43, the word "bath" should be --path--.

Signed and Sealed this

Fifteenth Day of September, 1992

Attest:

DOUGLAS B. COMER

Attesting Officer *Acting Commissioner of Patents and Trademarks*